ATTACHMENT 1

The Complete Executive Handbook

SELLING MID-BAND ETHERNET SERVICES

THE CARRIER'S GUIDE TO SELLING MID-BAND ETHERNET SERVICES TO ENTERPRISE CUSTOMERS

FOREWORD

Service providers worldwide are using Ethernet as means to drive down cost and deliver business-class services. With the advent of Mid-Band Ethernet, these service providers are now utilizing standards-based technology to extend the Ethernet service edge of their networks beyond fiber. With Mid-Band Ethernet, they are able to more efficiently deliver high-bandwidth, reliable Ethernet-based services while they wait for the economics to make sense for trenching new fiber. Mid-Band Ethernet allows operators to receive a quick return on invested capital while testing market demand before making more costly investments in fiber.

As service providers deploy, they've come to realize that Mid-Band Ethernet is much more than a mechanism to deliver a fatter pipe. It can be used to deliver a variety of business services, serve as a conduit for a suite of managed services of voice, video and data, become an integral part of a wholesale offering, or backhaul traffic from residential and/or wireless services.

No matter how it's being used, we're seeing a dramatic uptake in service provider adoption of Mid-Band Ethernet in large part due to its unique service creation capabilities. We expect this trend to continue and look forward to watching the market evolve.

— Stan Hubbard, *Heavy Reading*

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EXECUTIVE SUMMARY

Ethernet technology, since its original development and standardization in the 1970s, has become the mainstay of the enterprise local area network. Continued development of the technology and extension of the standards has increased the data rates in the LAN and enabled the technology to be widely incorporated into metro and wide area networks. Ethernet's cost effectiveness, ease of use, simplicity, familiarity, and bandwidth agility, coupled with the similarly ubiquitous Internet Protocol at the next higher layer of the communications protocol hierarchy, have driven Ethernet technologies to become the backbone of private data communications infrastructure (in-building, campus area, and wide area), and made Ethernet essential to the evolution strategy of virtually all Enterprise networks.

Enterprise applications across all industry segments have already moved, or are rapidly moving, to exploit the ubiquity and cost effectiveness of IP and Ethernet. On-line transaction oriented business applications with rapid response times have become critical to many businesses. Enterprise-wide PC and server networks are common in organizations both large and small. Ethernet-based Storage Area Network technologies allow organizations to implement Business Continuity/Disaster Recovery plans without incurring huge costs. Voice over IP Telephony has enabled the implementation of distributed call centers and global enterprise voice networks. Extensive use of videoconferencing, broadcast video, and on-line multi-media facilitates improved business operations while reducing employee travel costs. Extending these internal applications to customers, employees, and business partners over the Internet, through public web sites, and Virtual Private Networks is becoming common practice. These applications require networks with symmetric bandwidth, often tight performance objectives, and capacity in the range of 2 Mbps to 45 Mbps, particularly when grouped together in common networks.

Arguably all enterprise market segments: finance; health care; online and bricks-and-mortar retail; judicial and legal services; call center organizations; education; Federal, State/Provincial, and municipal governments; and manufacturing and industrial verticals; have implemented these enterprise applications from head office to branch offices, within metro areas, across the country and in some cases around the world.

To serve these demands, Service Providers have stepped up their offerings of high capacity, end to end services which provide Ethernet connectivity, terminating in the well-established 10/100/1000BaseT user-network interface. Service sets typically include Transparent LAN Services (TLS) connecting site-to-site, multipoint E-LAN services connecting multiple sites, and Dedicated Internet Access (DIA) services which connect sites to the world. Mid-Band Ethernet Services hit the 2 Mbps to 100 Mbps sweet spot filling the gap between T1/E1 and OC3/STM-1 services. Furthermore, unlike fiber-based access to business locations, Mid-Band Ethernet services are widely and readily available, making use of the copper plant already in place. Through standard pair-bonding techniques, high capacity, resilient connectivity can be achieved cost effectively. Mid-Band Ethernet provides the full Metro Ethernet service set and delivers fiber-like resiliency. As a result, Service Providers can now offer a ubiquitous Ethernet service offering over both fiber and copper facilities.

A Service Provider wishing to sell Mid-Band Ethernet services to Enterprise customers can identify prospects and potential applications within the industries identified. Each prospective customer will have their own immediate concerns: applications they have implemented and may be looking to cost optimize; applications they wish to deploy given a cost effective network alternative; or other near term objectives for their network. Conducting a detailed assessment of the information and communications applications of the prospect, including assessing the potential customer's locations, the applications delivered to each location, and the resulting bandwidth and performance requirements, will identify those sites for which Mid-Band Ethernet services are ideally suited. The value proposition of Mid-Band Ethernet includes:

THE TECHNICAL VALUE:

- Standards based – e.g. 10/100Base-T user-to-network interfaces and 802.1 protocols;
- Support for multiple Virtual LANs (VLANs) with different COS, enabling application specific QOS performance targets;
- Support for point-to-point TLS, hub-and-spoke, and multi-point E-LAN architectures;
- Built-in resiliency – when using multiple, bonded copper pairs, losing one pair in the connection does not cut the entire service;
- Scalable – adding additional pairs to an existing Mid-Band Ethernet service allows an increase in capacity, automatically retraining to the higher speed without taking the circuit out of service;
- Wide availability – Available virtually everywhere, including the nearly 86% of business locations for which fiber has not been deployed.

THE BUSINESS VALUE:

- Ease of use and low cost of interface – uses widely available, inexpensive interface and switching/firewall equipment; no Frame Relay, ATM or T1/E1 interface cards are required;
- Widely available deployment and support knowledge, reduced or no training cost;
- Tailored – begin with the proper estimated level of required capacity for any application and add capacity as the number of applications and/or link utilization grows;
- Availability – begin to deploy high capacity enterprise applications, or mixed-use networks immediately, no waiting for service provider fiber construction delays;
- Reduced overall cost for service capacity in the 2-100 Mbps range.

This value proposition, unmatched by T1/E1 or fiber-based services, will demonstrate to the prospect's decision makers the significance of the opportunity available.

The flexibility and cost effectiveness of Mid-Band Ethernet services over the existing copper infrastructure will enable rapid payback and high return on investment for any of their key enterprise initiatives.

INTRODUCTION AND BACKGROUND

THE UBIQUITY OF IP AND ETHERNET IN THE ENTERPRISE

Ethernet technology, since its original development and patent in 1976 and standardization at 10Mbps by a joint working association (Xerox, DEC, and Intel) in 1979, has become the mainstay of the enterprise local area network. Continued development and extension of the standards have expanded the media over which Ethernet can be carried from coaxial cable to twisted copper pairs, to fiber, and to wireless. Evolution has also increased the date rates available to 1000Mbps/1Gbps over a local office LAN and 10Gbps (soon to be 100Gbps) over fiber in the metro and wide area networks.

Cost effectiveness, ease of use, simplicity, familiarity, and bandwidth agility, coupled with the similarly ubiquitous Internet Protocol at the next higher layer of the communications protocol hierarchy, have driven Ethernet technologies to become both the backbone of private networks (in-building, campus area, and wide area) and essential to the evolution strategy of virtually all Enterprises. Many critical business applications such as Enterprise Resource Planning (ERP), file sharing, Storage Area Networks, Voice over IP (VoIP) telephony, video conferencing, corporate video broadcast, and other multi-media services such as on-line training, are increasingly being converged onto metropolitan area, campus area, and long haul Ethernet networks.

AVAILABILITY, SIMPLICITY, AND CONSISTENCY ACROSS THE ENTERPRISE

Availability, simplicity, and consistency have established Ethernet and IP as the communications technology of choice across the enterprise. Ethernet protocols, physical interfaces and supporting technologies have been standardized, commercialized, and adopted to such a degree that they now provide the most cost effective communications medium on the market today. The most common of the early Ethernet interfaces, an RJ-45 jack and 10Base-T electrical interface, has been extended to support 100MBps and now 1Gbps over conditioned copper pairs in the LAN. The standard originally developed for personal

computers, small servers, printers and local area switching equipment, has now been adopted by voice telephony equipment, video transmission equipment, and specialized industry equipment such as automatic banking machines, manufacturing robots, and industrial control systems.

SERVING THE NEED – THE GROWTH OF CARRIER ETHERNET

All of these business information, voice, and video applications, demand that end-to-end network connections be provisioned and managed such that each connection's individual Quality of Service (QoS) performance requirements (packet delay, packet jitter, and packet loss) are met. Service Providers have found that, unlike ATM or Frame Relay, Ethernet technology can provide a cost effective infrastructure for high-bandwidth, tight tolerance, real-time voice and video services. As a result, they have been rapidly exploiting the Ethernet opportunity, allowing them to not only enjoy the technology's simplicity and flexibility, but to realize huge reductions in the cost-per-bit for network switching and transport; thus permitting them to offer enriched, high-bandwidth, more profitable business services. Carrier Ethernet services, in the metro and wide area, are now offered in all major markets.

MID-BAND ETHERNET SERVICES TARGET THE ENTERPRISE SWEET SPOT

Mid-Band Ethernet Services provide extension of the enterprise LAN into the Metro Area or Wide Area over existing copper access facilities. It offers the familiar 10/100Base-T RJ-45 jack as a service demarcation point, symmetrical services typically targeted in the 2-20Mbps range (with potential to provision service capacity up to 100 Mbps) and support the full range of VLAN switching capabilities, bandwidth profiles, and QoS performance profiles.

For a more in-depth definition and exploration of Mid-Band Ethernet Services technology, please refer to the companion Mid-Band Ethernet Services: The Complete Executive's Handbook available from Overture.

Business on-line inquiry/response applications often require transaction sizes ranging from 2000 bytes to a typical 150KByte web page. With overhead these would meet a 1 second network response time on a 2 Mbps link. Large 100 Mbps file downloads (such as a high resolution medical image) can be transmitted in under a minute using a 15 Mbps stream. Videoconferencing streams typically employ a 500 Kbps to 1.5 Mbps traffic stream depending on the compression and encoding schemes used. Voice streams using PSTN grade G.711 encoding (64 Kbps voice) would require approximately 1.92 Mbps stream to replace 24 simultaneous calls (similar to a T1/1.544 Mbps TDM trunk group), or through G.729 compression, 3 times the number of channels.

Each of these examples falls into the Mid-Band Ethernet sweet spot of 2-100 Mbps, either stand-alone or, as is more frequently the case when an enterprise requires transport of multiple applications, as multiple logical streams encompassed within a single connection between locations.

HOW MID-BAND ETHERNET SERVICES ARE DELIVERED

Mid-Band Ethernet Services employ Metro Ethernet Service Edge technologies based on the IEEE 802.3ah Ethernet in the First Mile standard ratified in 2004. The long reach option of IEEE 802.3ah used for Mid-Band Ethernet services, known as 2BASE-TL, was designed to address the service gap between T1/E1 and DS-3/STM-1. Implementations provide nominal symmetric maximum data rates of 15 Mbps per copper pair (up to approximately 3Kft) and data rates of up to 2.3 Mbps per pair of voice-grade copper over CSA (Carrier Serving Area) distances of 2700-3600m (9-12Kft). While 90% of deployments are within 12Kft, some commercial Mid-Band Ethernet deployments are well beyond 20Kft. Up to 8 copper pair can be bonded together to deliver the desired bandwidth. Outside Plant Cabinets and 2BASE-TL repeaters can also be used for long loops and remote end users.

Furthermore, the 802.3ah standard defined a new multi-pair bonding scheme which is transparent to the higher Ethernet layer. Incoming Ethernet frames are passed to this bonding layer, broken into fragments, a fragment header is prepended to each, and the

fragments are distributed across the individual copper loops. The fragment headers are used to re-sequence and reassemble the frames at the receiving end. By using this bonding technique across up to 8 pairs, data rates up to 100 Mbps may be offered over shorter distances and services of 10-20 Mbps can be offered throughout a typical carrier serving area.

Contrary to other Ethernet Link Aggregation standards such as IMA and multi-link frame relay, the 802.3ah pair bonding technique allows the loops within a bonded group to operate at different data rates. Individual frames may be split into variable-sized segments to minimize latency and maximize utilization of the different loop speeds. While these techniques introduce efficiency and performance benefits, they also add the attributes of resiliency and availability to the supported services. With IEEE 802.3ah, bonding bandwidth available to customers can change dynamically as pairs may come and go due to circumstances such as an access plant problem (e.g. cross-talk and noise, wet cables, poorly spliced pairs). Unlike T1/E1, 802.3ah bonding ensures the connection remains operational. Combined with higher per-pair bandwidth potential, the multi-pair bonding technique enables highly reliable, high bandwidth service offerings.

For a more detailed explanation of the operation of the underlying Mid-Band Ethernet Service technology, please consult the companion Mid-Band Ethernet Technology Handbook: IEEE 802.3ah 2BASE-TL for Executives available from Overture.

DRIVING THE TRANSITION FROM T1/E1 AND FRAME RELAY TO MID-BAND ETHERNET

As noted in the Introduction, Enterprises continue to adopt IP-based solutions that dramatically grow their consumption of packet-network capacity. To deliver the quality of service expected by end-users of mission critical online applications and real-time voice and video applications, these solutions must be supported by end to end transport networks with high capacity, high availability, and high Quality of Service (low packet loss, packet latency, and packet jitter).

Consequently, service providers have invested to build out carrier-grade metro area Ethernets and have deployed fiber optic communication systems directly into large office buildings in most major urban centers. By positioning network edge switches in building telephone closets or in server rooms (where available), they offer Ethernet services with a range of speeds over the shared access fiber. With dedicated network capacity, or even implemented as over-booked, shared capacity access networks, the cost of such services remains relatively high. Accordingly, over 70% of the Metro Ethernet services operate at 10 Mbps today. This provides a fine balance between the capacity and QoS required by the network applications, and the price of the service to the enterprise customer.

With the capital investment required (for construction, ducting, electronics, etc.) to install fiber still remaining high, it is not yet economical for service providers to deploy fiber for only one or two 10 Mbps connections. Consequently, almost 86% of business locations remain served only by copper cable. Therefore, while the enterprise applications run on the ubiquitous 10/100 Mbps Ethernet LAN inside the office environment, WAN links have historically depended upon the availability of legacy Frame Relay and dedicated T1/E1 services. The resulting lack of bandwidth and inability to provide ensured QoS has severely restricted the ability of enterprises to evolve their information systems and technology to the degree that they desire.

Mid-Band Ethernet Services allow Service Providers to offer 10 Mbps to 100 Mbps and sub-10 Mbps services over copper widely and cost effectively. According to Vertical System Group, these services are growing exponentially with a quantifiable U.S. market of 1.1 million 2-100 Mbps connections and a quantifiable European market of 1.25 million 2-100 Mbps connections over five years. (For additional market information, please see the Mid-Band Ethernet Services: The Complete Executive's Handbook.) This translates into a Carrier service revenue opportunity in excess of $15 billion per year for Mid-Band Ethernet business services. Many Carriers are also expanding the applications of Mid-Band Ethernet to address infrastructure back haul requirements, such as mobile wireless backhaul, wireless mesh (802.11) backhaul, and DSLAM (DSL Access Multiplexer) backhaul.

TARGET APPLICATIONS IN THE ENTERPRISE

ENTERPRISE APPLICATION GROWTH

Virtually all organizations continue to adopt IP-based solutions and dramatically grow their consumption of packet-network capacity, whether they are private sector for-profit companies; public sector entities such as governments, health, or education organizations; or non-governmental organizations. Moreover, once an organization's size or geographic reach exceeds the boundaries of a single location, their enterprise applications are consumed by users (or their customers) remote from the application and/or database server infrastructure.

To deliver the grade of service expected by end-users of mission critical, online applications and real-time voice and video applications, enterprise solutions must be supported by end to end transport networks with high capacity, high availability, and high Quality of Service attributes (low packet loss, packet latency, and packet jitter), not only within the LAN, but also extend beyond the LAN across MAN and WAN topographies. The following describes some of today's essential categories of information systems and communications applications, while also providing a high level view of the associated demands on the underlying LAN, MAN, and WAN for effective operation across any topography.

TRANSACTION ORIENTED APPLICATIONS

Transaction oriented, or Inquiry-Response, applications are those for which an enterprise user (such as a customer sales clerk, call center agent, or office worker) enters data into an electronic form displayed on their desktop computer, submits it to a remote application/database server, subsequently receiving a response largely as text. Typically, these are in one of three forms:

- Specialized client application software on a standard client device (desktop PC, laptop, or mobile device) communicating with a specialized back-end server (ERP applications for example);
- Intranet applications where the end-user employs a browser with standard web technologies (such as HTML, XML, Javascript, etc.) on their client device interacting with a Web server/Application server/database server infrastructure; or
- Specialized client devices such as Cash Registers and automatic banking machines with attached or embedded credit/debit card readers, communicating with a remote server.

Regardless of the physical devices involved, transaction oriented applications have many common attributes: (i) each inquiry and most responses have only a small amount of data to transmit; (ii) the requirement to get the response back to the end user is very short (2-3 seconds) in order to avoid user dissatisfaction and loss of productivity; (iii) they are mission critical to the underlying business (e.g. capturing revenue, selling a product, providing patient information); (iv) the client devices are often found in clusters; and (v) they typically operate in a high volume environment with thousands of such transactions during the busy period.

In order to successfully achieve the transactions' round trip response time objectives (including processing time), one way transmission delays (transit time plus queuing delays) must be sub-second. Mid-Band Ethernet Services in the 10 Mbps range ensure the elimination of potential chokepoints in the path between client device and server. Secondly, with support for multiple classes of service over shared links, mission critical transactional applications will not be affected by lower priority applications such as file transfer.

ENTERPRISE-WIDE PC NETWORKS

Enterprise wide personal computer networks are comprised of a mixed group of applications that facilitate information storage and sharing. Users, distributed across the enterprise, may access shared file servers for uploading or downloading large documents such as corporate forms, training and user manuals, multi-media training files, etc. One or more centralized enterprise email servers are accessed on a constant basis by all users across the network for the sending and reception of email messages - with more and more of these messages weighted down with large attached documents that are often

distributed to large groups of recipients. Network loads continue to grow significantly as many organizations move to on-line document storage and management, including huge numbers of scanned regular and large format documents (such as medical charts, legal contracts, purchase orders, bills, check images, architectural drawings, etc.). With scanned documents requiring anywhere from 2-3 MByte per page, 60 MByte or more for a single high resolution diagnostic image, to 125 MByte for each architectural drawing, high capacity networks are key to reasonable user access.

In addition, important tools for network security and administration used in many environments (such as MS Active Directory in a Microsoft network or other LDAP-based products), must be accessed each time someone logs into a PC attached to the network - for user authentication and authorization of access to appropriate resources, servers and applications. At peak periods, such as in the early morning and just after lunch, the volume of users logging into the network in a short period can be quite significant.

Mid-Band Ethernet services provide the high capacity required to allow access to a 60 MByte file in under a minute at 10 Mbps, or half that time at 20 Mbps. A legacy T1/E1 access link would throttle the transmission down to a point where it would require over 6 minutes to transmit a single image of this size - assuming nothing else is using the network link (a low probability unless it is a dedicated imaging network). Similarly, accessing a 20-30 page document from a centralized server or downloading email with a couple of large attachments, would incur comparable delays across a T1/E1 or Frame relay link.

STORAGE AREA NETWORKS

A Storage Area Network, or SAN, is a system of storage devices such as disk drives, tape drives, CD arrays, etc. connecting over a communications network to a series of computers, typically application and/or database servers. Rather than the file-based access of PC networks as described above, data is written to storage and accessed on a record-by-record or block-by-block basis. In many instances, in addition to offering shared storage, SANs are implemented to replicate data into a redundant, secondary remote storage array. This implementation allows superior business continuity and rapid recovery should a disaster strike the location of the primary storage arrays. Demand for SAN technology has increased significantly since recent terrorist attacks, and since the implementation of regulatory requirements such as Sarbanes-Oxley and similar legislation.

Previously, SANs were implemented with specialized, gigabit speed protocols such as Fiber Channel Protocol. Introduction of Ethernet-based SANs has reduced the price of equipment and enabled a more cost effective underlying network infrastructure. However, at a minimum, the speeds and reliability enabled by Mid-Band Ethernet services are required to achieve reasonable performance.

VOICE OVER IP (VOIP) TELEPHONY

IP Telephony, often just called VoIP (Voice over IP), has become the industry standard for the introduction of modernized enterprise voice communications systems. Among other capabilities, modern IP telephony systems enable:

- Distributed office locations to be connected into the same call control server, permitting an Enterprise–wide, extension-based dialing plan;
- Small offices to be served using only IP Phone sets, eliminating the costs of a small PBX/Electronic Key system and related PSTN access lines;
- Carriage of all intra-enterprise calls over an IP network at a lower cost than dedicated trunking facilities;
- Distributed call centers with agents at multiple locations handling calls from the same incoming call stream (such as a specified 800 number);
- Resilient failover capability where call control and signaling servers in secondary offices can assume the load in case of a failure of the main IP PBX installation; and
- Employees to Telework from home with all of the features of their office extensions.

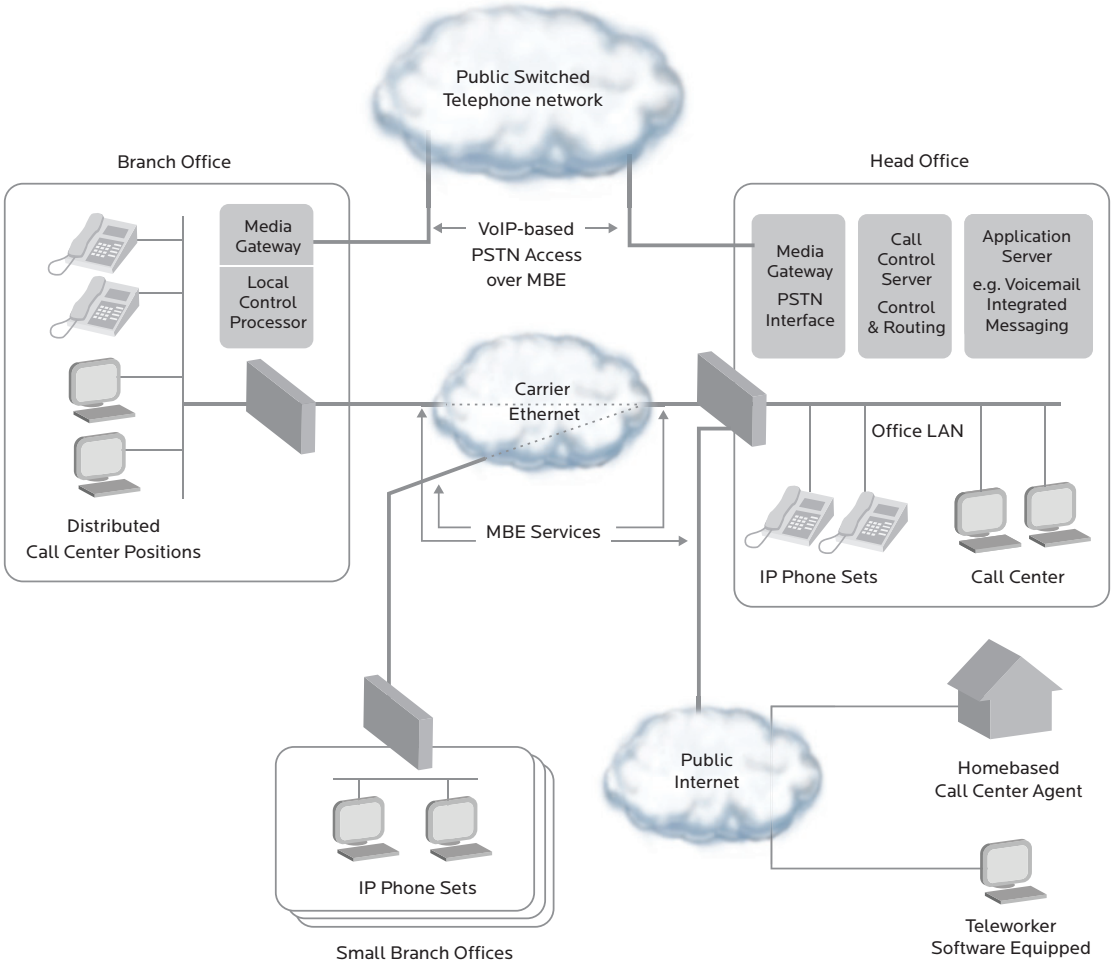

Figure 1. VoIP telephony Infrastructure

To assure adequate voice call quality between office locations, the IP network must meet premium performance parameters (e.g. < 60 ms one way packet latency, < 20 ms packet jitter, < 1% packet loss ratio). Furthermore, depending on the inter-office voice encoding scheme chosen (e.g. G.711 enabling PSTN quality voice at approximately 80Kbps per active call) approximately 2 Mbps is required for 24 simultaneous conversations as would be typical on a traditional T1/E1 point-to-point trunk.

The advantages of Mid-Band Ethernet services in linking sites within an enterprise wide IP Telephony system include:

- Ethernet enables the implementation of multiple Classes of Service, including the Real Time Class (RFP 2598) required to ensure VoIP packet streams meet the performance parameters noted above in mixed use environments;
- Ethernet allows flexible use of the bandwidth, so that other applications may make use of the bandwidth in low call volume periods;
- Mid-Band Ethernet services typically offer a lower bandwidth cost per bit than dedicated T1/E1 trunking;
- The resiliency of the copper pair bonding technique used is such that losing one pair does not cause loss of the entire packet stream (unlike a single pair per direction xDSL scheme where losing either pair drops the entire connection).

Mid-Band Ethernet services are ideal for linking IP telephony equipment in distributed enterprise environments.

DEDICATED INTERNET ACCESS

Most organizations of reasonable size today maintain a public Internet site to provide product and organization information; news, reference information, and advertising; and in the case of many retailers, offer product purchase options. Even small municipal governments increasingly offer Internet based information and transactional capabilities (e.g. the municipal library's on-line book catalog). Beyond the obvious need for incoming and outgoing email transport, business employees constantly need to access information from external sources on the Internet, and teleworkers constantly need to reach into their office LAN environment to access information. Thus, it is apparent why Dedicated Internet Access (DIA) services are purchased by many small businesses, and the vast majority of medium to large businesses.

While very large corporations may be able to invest in the expense of 100 Mbps DIA and the deployment of fiber links into their main server hosting sites, the average business can rarely justify the considerable cost. Nevertheless, most Internet Service Providers today offer reasonably priced 10 Mbps Internet Access services, a speed which effectively meets the needs of businesses and their web-transaction and intranet applications as described above. DIA services in this 2-100 Mbps range may be rapidly deployed to practically any business location using underlying Mid-Band Ethernet services.

VIDEOCONFERENCING

When one couples the rapidly escalating costs associated with travel, with organizations' desire to enhance productivity of employees by eliminating time lost due to travel, it is easy to see why site-to-site and multi-site videoconferencing continues to be a growth industry. Videoconferencing is yet another application where equipment makers have adopted the use of IP / Ethernet communication technologies and the enterprise network for connectivity. Implementing videoconferencing, while enabling an effective mode of interpersonal communication, does place significant stress on a traditional shared WAN infrastructure that uses T1/E1 or equivalent speed technologies.

Although video codec settings vary, the standard bandwidth requirements for video conferences range from 500 Kbps to 1.5 Mbps per video stream (a single stream in each direction for an end site, multiple streams for a video bridging site). Using a higher bandwidth stream enables better voice and picture quality. More importantly, unlike downloaded or broadcast video, the videoconferencing stream must be symmetric, equivalent incoming and outgoing bandwidth. Finally, while not as strict as VoIP performance requirements, video streams also require low packet loss and low packet jitter.

Videoconferencing can be implemented on its own dedicated network. However this results in a significant amount of unused bandwidth when the conferencing units are not active. Mid-Band Ethernet Services allow videoconferencing to be cost effectively coupled with other applications (such as VoIP and file sharing services) on the enterprise LAN/WAN infrastructure by exploiting its CoS prioritization scheme and bandwidth management capabilities when active, while allowing effective use of the bandwidth by other applications when inactive.

BROADCAST VIDEO AND ON-LINE MULTI-MEDIA

Many organizations have adopted on-line training as a cost effective method of training many employees distributed at office locations throughout the organization. These training courses frequently involve not only text-based information, but also video-based and multi-media components delivered directly to user PCs or PC-based projectors. Courses may be offered either by live video broadcast from a central site; by educational video clips and lectures streamed from a centralized web site and video server; or by downloaded video or multi-media files such as QuickTime video, Windows video, Real Player video, or Macromedia applications - to name a few.

These applications require significant bandwidth (again dependent on the video encoding scheme and/or the size of the media file), particularly where several students at a remote location are being trained within a short time span. If the video is too choppy, the course becomes difficult to follow. If the file download takes too long, students will not have the patience to wait and the efficiency of the training application is lost. Minimum bandwidth requirements are in the range of 500 Kbps per student in the branch office, surpassing the typical T1/E1 connection's capability to deliver effective service.

IMPLICATIONS FOR THE CORPORATE WAN

Given: the explosive growth of IP-based applications; the high reliability required for mission critical applications; the higher bandwidth requirements for many applications; the tight performance requirements for VoIP and video; and the mixed classes of traffic contending for the same capacity; and that the majority of business locations are still served only by copper access facilities; what does all this mean for the enterprise WAN?

It means that many large organizations are adopting metro and wide area Ethernet connectivity for their branch offices. It means medium sized organizations are adopting site to site transparent LAN interconnect services, in the Mid-Band range of 2-100 Mbps, most frequently at the 10 Mbps point to take advantage of native 10/100Base-T interface technology. It means a growing market for widely available, affordable Mid-Band Ethernet based service solutions.

APPLICATION OF MID-BAND ETHERNET SERVICES IN VARIOUS MARKET VERTICALS

Selling products and services, particularly to enterprises, will typically benefit from a solution-based (rather than 'cookie-cutter') approach. The Sales Team must look for applications of the services in the prospective customer's business, describe the solutions, and present the business benefits and value proposition to the customer. In addition, the application of information and communications technology by one member of an industry vertical can often be exploited by other members of that industry who are also potential candidates for sale of a similar technology. Mid-Band Ethernet services are no different. The following section examines several market verticals, along with their deployment of the technology and business applications previously described, which demand Mid-Band Ethernet.

THE FINANCE INDUSTRY VERTICAL

Banks, trust companies, brokerages, and insurance companies make tremendous use of information and communications technologies. They are often similarly structured with a corporate and/or regional Head Office(s), one or more Data Centers (often two for business continuity reasons), and anywhere from dozens to hundreds of branch offices in proportion to the size of the enterprise.

First, finance industry employees in branch offices use a number of mission critical transaction-oriented business applications. Bank client account and information systems are used for managing personal and business banking transactions, handling deposits, withdrawals, transfers, etc. Banks have also implemented automated banking machine networks into their branch premises and third-party locations. Brokers access current price information and place orders with their centralized on-line trading systems. In a similar fashion, insurance company representatives, often grouped in call centers, provide clients with policy information, new policy price quotations, etc., from their client information or contact management systems.

Second, in order to offer new products to their clients, financial institutions provide information to branch employees via their corporate intranets. Downloading and printing brochures for clients, on-line query of the latest product information (e.g. interest rates), are just a few of dozens of types of information accessed daily. Third, VoIP technology can be used to effectively link branches into the overall corporate voice telephony infrastructure.

Inter-branch calls, distributed call centers, and hand-offs from centralized call centers to local branches, can be handled securely and cost effectively deliver high quality customer service. Finally, more and more financial institutions are using document imaging to capture signed purchase orders and contracts, signed policies, and processed checks to save the cost of storing and transporting thousands of physical documents each day.

Together, these applications demand that the branches be served by a secure, dedicated, resilient network of sufficient capacity. Converging traffic and consolidating Branch access to the corporate network onto a single, more cost effective Mid-Band Ethernet link should be a key target.

THE HEALTH CARE MARKET

After years of neglect of its basic IT infrastructure, there has lately emerged a new emphasis on modernization of the information and communications technology infrastructure in the primary, acute, and community (i.e. home care and long term care home) sectors of the health care industry. In addition to the widespread use of patient and case file information systems, Patient-centric customized Electronic Health Records (EHR) are being implemented in many jurisdictions. Picture Archiving and Communications Systems (PACS) are creating and storing high resolution diagnostic images for shared access across the system. Document scanning and management systems are being used to capture and replace paper charts. And telemedicine applications allow remote patients to be examined and diagnosed by physicians from a central location. All of this is being done in an environment in which health organizations are extending themselves beyond individual hospitals into campus and metro-wide environments, while incorporating their primary care and community care health partners.

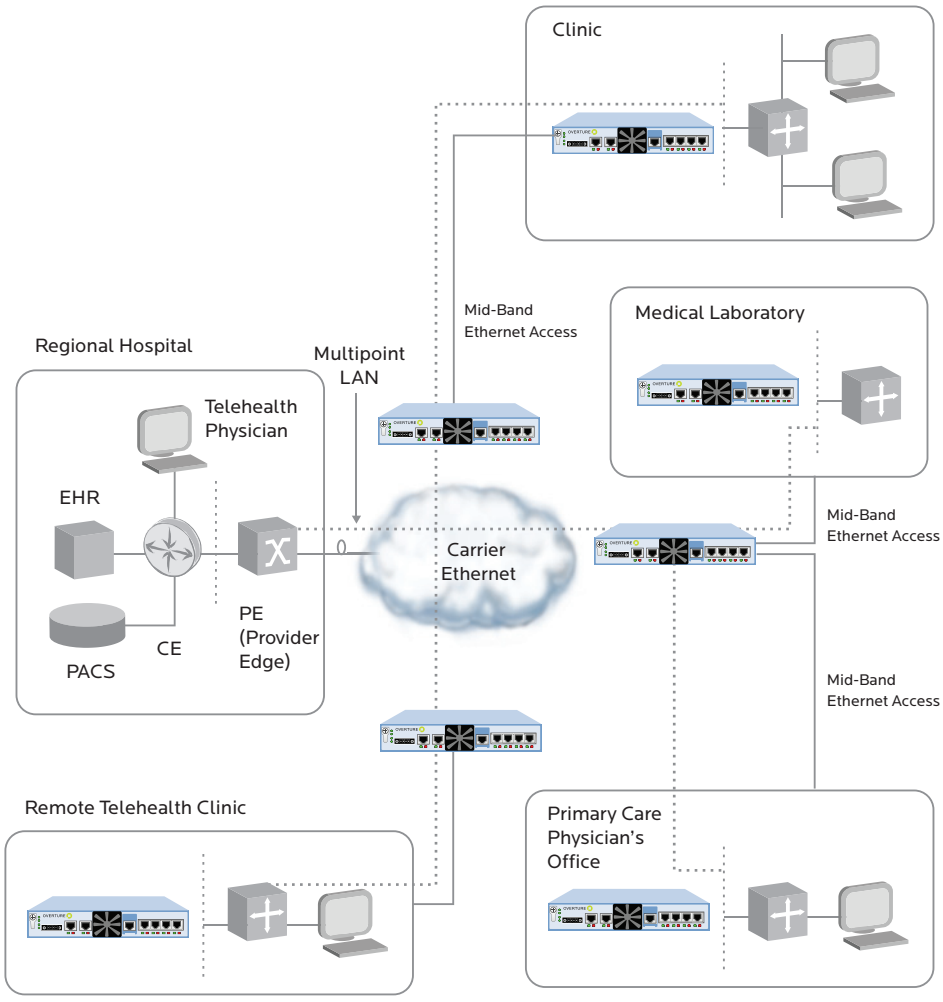

Figure 2. Mid-Band Ethernet in Health Care

Each of these applications is adding dramatically to the demands on the underlying communications infrastructure. For example, high resolution PACS images, scanned paper charts, and EHRs may consist of files sized in hundreds of megabytes, for which clinical personnel cannot wait 20-30 minutes for download and display, particularly in urgent care situations. Also, telemedicine equipment such as stethoscopes and video links require high quality, low latency, and low jitter links to remote locations. The US Senate recently saw legislation introduced to encourage the use of health information technology to remotely monitor patients, provide emergency room videoconferencing, and EHRs in rural areas.

Where are the best solution opportunities for the application of Mid-Band Ethernet services in the Health Care market? Clinical personnel such as doctors, nurse practitioners, and specialists are in short supply and their time is highly valuable. Locate organizations and their partners who are implementing the types of projects described above and, while major hospitals may have fiber deployed for their communications needs, look for:

- Clinics and specialists at smaller offices who require access to diagnostic images created and stored in the major hospitals;
- Primary care physicians' offices which may create and access Health records;
- Community care organizations with facilities in smaller buildings in residential communities and small towns;
- Remote telehealth offices and/or small rural hospitals.

Implementation of 10 Mbps or higher services at each of these locations will deliver significant productivity gains for the scarce clinical personnel.

THE RETAIL INDUSTRY

There are two primary areas of focus for the application of Mid-Band Ethernet services in the retail industry: on-line retail or eCommerce; and, the combined retail terminal (i.e. cash registers) and supply chain/inventory management applications in use by major retail chains.

Web-sites with on-line retail catalogs deliver high quality product images and descriptive information. At the same time, the sites must process On-line purchase transactions - potentially many thousands of transactions per second depending on the market share of the organization. As a result, bandwidth requirements are significant. On-line shoppers, notoriously impatient, prefer to find another vendor rather than wait for slow performance delivered by an on-line retail system, jeopardizing profit potential.

On-line retailing is the great equalizer for many small to mid size specialty retailers, with national or global reach made possible without the cost of an extensive bricks-and-mortar infrastructure. Real estate costs are saved by using prime real estate in urban centers for storefronts while keeping back office operations in lower cost, suburban industrial parks. Dedicated Internet Access links at 10-20 Mbps provides the performance and capacity needed and is more readily available over copper in these locations where fiber deployment is a rarity.

Virtually all large and many medium retail organizations (including hard goods, food, pharmaceutical and even gasoline) have implemented, or are in the process of implementing, extensive supply chain management systems. These begin with the specialized electronic cash registers (or gas pumps in the case of gasoline vendors) in the stores which scan products as they are sold and provide credit or debit card services to customers. Financial transactions are routed to the financial networks and require rapid response times to prevent customer displeasure and productivity loss. Furthermore, inventory information such as changes in available stock levels and need for additional stock (perhaps summarized locally) is routed to regional or corporate data centers.

While they may sell different ranges of products, these organizations have in common a widely distributed network of retail outlets. These locations are rarely served by any facility other than the legacy copper network. Some retailers have tried to overcome this limitation by implementing expensive roof-top satellite terminals and transponder capacity. Mid-Band Ethernet services can deliver the capacity needs while (i) providing better network

performance than the 250ms round-trip delay of each packet to geosynchronous orbit, and (ii) replacing the high cost of the satellite terminals and network with a cost effective 2-100 Mbps copper-based network solution.

THE JUDICIAL AND LEGAL SERVICES MARKET

Mid-Band Ethernet services have a natural application within the larger Legal service firms and judicial system. Large law firms generally have sites in multiple major cities. They make use of technology to centralize case files including scanning, categorizing, and storing evidence, contracts, etc. Broadband communications also allow for remote, video-based depositions with legal teams in multiple cities. Remote Video-based court appearances are becoming more frequent, where it is unproductive or in-advisable to move the accused to the court house.

Such applications are still in their infancy, partly due to the limited availability of sufficiently high capacity and economically acceptable communications services into Law Offices outside large urban office buildings, into county or regional detention facilities, or into court houses. Mid-Band Ethernet services offer the opportunity to address these limitations.

THE EDUCATION VERTICAL

The education market, both elementary and high school boards of education as well as post-secondary institutions, has been increasingly exploiting broadband communications in a number ways: (i) organizations with a centralized school board office are delivering on-line applications, voice, and video to a number of widely distributed school sites; (ii) connection between distributed university campuses; (iii) real-time video based instruction and two-way interaction between multiple sites at elementary, high school, or post secondary levels; (iv) distance learning via internet-based video broadcast of lectures; (v) on-line courseware and video-based lectures streamed or downloaded on demand to libraries, college residences, or students' homes.

Common characteristics of these applications include: a number of distributed locations; locations rarely within a typical dense urban setting and highly unlikely to be economically served with optical fiber; and most importantly, locations with a need for significant bandwidth to carry streamed audio and video content often mixed with less performance sensitive file download and email traffic. Because students may be watching or interacting for 90 minutes or more in these remote learning situations, usability requirements demand that the video streams are not choppy, do not have excessive frame dropouts or packet losses causing pixilation, or have significant noise or delays in the audio stream. The bandwidth requirements are often 1.5 Mbps (for video) per stream. Using a single Mid-Band Ethernet access service in the 10-20 Mbps range interconnecting the education infrastructure will accept multiple, simultaneous, high-quality connections while maintaining adequate capacity for the day to day business applications, email and internet-based research to continue without cross impacts.

CALL CENTER VERTICAL

Call centers are an integral part of many of the industries discussed previously (e.g. catalog or online retail, financial services, etc.). In addition, the call center market segment consists of organizations that specialize in incoming and outgoing call handling such as polling firms, telemarketing firms, government information centers, Technical help centers, etc. Irrespective of whether the call center is the whole business or just a part of the business, implementing a distributed, virtual call center can provide significant benefits to the business.

In the largest of call centers, a single virtual call center may be distributed over several sites, in different cities, sometimes around the globe. This allows the organization to have access to a greater number of trained employees, potentially speaking several languages, and allows call centers to cut down on labor costs for overnight employees as calls can be transferred transparently to centers operating in regular business hours. Furthermore, distributed call center technology provides natural business continuity and disaster recovery through redundancy and physical distribution of personnel and equipment. It facilitates the set up of call centers in lower cost suburban or small town areas with transparent (to the callers) connections to the public switched telephone network.

These advantages of Voice-over-IP based virtual call center technology are available today from all major voice telephony suppliers. However, high voice quality IP Telephony puts significant performance and capacity demands on the network. In addition, call center personnel are usually supported by on-line information systems (customer info, ordering, etc.) at the multiple locations. Mid-Band Ethernet services, delivering cost effective, QOS ensured, high capacity VoIP packet streams between locations, are a natural accompaniment to VoIP technology in achieving the value proposition above.

MANUFACTURING AND INDUSTRIAL

Whether it is electronics, automobiles, appliances, household goods, toys, chemical products, pharmaceuticals, etc., major Manufacturing enterprises depend on the effectiveness and accuracy of their ordering systems and supply chain management systems to remain at the forefront of very competitive industries. Orders received at any of a number of Sales offices enter the fulfillment process, requiring data-center based inventory records to be queried, assembly orders to be communicated to remote plants, sub-tending orders to be issued to parts or materials suppliers, and shipping services to be notified. Supply chain management and enterprise resource planning systems have become highly advanced and interlinked tightly with billing and general ledger systems.

Supply chain management systems have delivered economic benefits to manufacturers in the form of reduced inventory on hand, shorter cycle time from order to shipping of the product, solved some scalability problems, and improved company cohesiveness. These systems have become embedded as the critical arteries of many manufacturers, the very operation of the business tied to the continued flow of information. When the electronic backbone does not function as it should for more than a few minutes, when packets are seriously delayed or dropped, when critical links in the network go down, orders are delayed and revenue can be severely impacted. Capacity, Class of Service prioritization, performance guarantees, and improved reliability of Mid-Band Ethernet service ensure the continued flow of the information lifeblood to the widely dispersed elements of the organization.

END TO END SERVICES AND MID-BAND ETHERNET

Service Providers have characteristically implemented a range of high capacity, end to end services which provide Ethernet connectivity, terminating in the well-established 10/100/1000BaseT User network interface at the customer locations. These are:

Transparent LAN Service (TLS) – Connecting Site-to-Site: Also known by the Metro Ethernet Forum as E-Line Services, Transparent LAN Services offer customers site-to-site connectivity. Whether the service locations are in the same urban area or in multiple cities, the Service Provider's gigabit Ethernet, MPLS, or SONET-based core network infrastructure can provide the metro-area or wide area connectivity while Mid-Band Ethernet services can provide the critical first mile access components to the customer locations.

Multipoint E-LAN Service (E-LAN) – Connecting multiple Sites: E-LAN Services, as defined by the Metro Ethernet Forum, join three or more sites in a common Ethernet. These services are dependent on a packet or frame-switched core network, typically Ethernet in the metro area and either Ethernet or MPLS for the inter-city connectivity, linking Provider Edge (PE) switches. While PE switches may be deployed in large buildings and linked to the network via fiber, the majority of business locations will be connected to a remote PE switch using available copper facilities.

Dedicated Internet Access (DIA) – Connecting Sites to the World: Business DIA services provide a high capacity, symmetric, link from a Customer's location to the world. This will enable Customers to access the Internet to download information, receive email, and more importantly for some industries, allow the world to reach into their websites and or eCommerce websites. DIA services consist of two major assemblies of components: the Internet Gateway router, domain and addressing components; and the access service from the gateway router to the firewall on the customer's premise. Mid-Band Ethernet services are the ideal solution for the latter.

Metro Ethernet, Inter-City and Global Scope: These Ethernet services which start in the first mile are not limited in geographic reach. As small enterprises have grown to expand to a national scope and large enterprises have grown or amalgamated into global organizations distributed across multiple cities on multiple continents, their need for economic, high quality network connectivity grows exponentially. Mid-Band Ethernet services can provide the critical access to many customer locations that could not otherwise be linked into the organization.

Anywhere Fiber Facilities Are Needed But Not Available: Mid-Band Ethernet provides connectivity for applications where fiber would be used but is not available. Multi-location businesses are connected via fiber but often some locations do not have access to fiber facilities. Availability of fiber is extremely limited at Cell towers. Mid-Band Ethernet delivers the same full Layer 2 Ethernet service set as provided over fiber so all locations can be seamlessly connected with a ubiquitous Ethernet service offering. Mid-Band Ethernet delivers up to 7 times more bandwidth that T1/E1s over the same copper facilities. Unlike T1/E1s, Mid-Band Ethernet also provides fiber-like resiliency.

POSITIONING MID-BAND ETHERNET SERVICES

Consider the potential implications of the applications and markets discussed above. With the explosive growth of IP and Ethernet applications in the enterprise, virtually every significant market is a candidate for Mid-Band Ethernet services. The challenge to the sale of the service is effectively identifying the applications, identifying target service locations, positioning the service amongst the range of options available, and most importantly, clearly identifying the technical advantages and business value to the prospective customer.

Identify the Business Applications: Look at the prospective customer and their market segment. Using the target application and industry oriented information above, identify the customers' current distributed business applications. More importantly, identify which of these applications could make a difference to their business if it could be implemented quickly and economically. While the implementation or improvement a single target application may be sufficient justification for some customers, the transparency of Ethernet and Mid-Band Ethernet services encourages that the sales proposition focus on the entire range of applications that may be cost effectively enabled over a single connection.

Identify the Locations: A key consideration: does the customer have a large number of locations, and how are they distributed geographically? Are they within the same city, distributed across the country, or dispersed globally? Are the locations in the urban core, in a campus setting, in suburban business parks, in other suburban areas, in small towns, or in rural areas? The proposed application of first mile access services will vary according to the location and distribution.

Prospects with only a single major location are likely looking for high speed access to their customers, either via the public Internet or possibly via a semi-private Extranet. High capacity DIA and/or TLS connecting LAN firewalls are opportunities. More frequently, prospects will have a larger centralized location (e.g. a head office or data center) and multiple small locations (e.g. branch offices or schools). Depending on the customer's internal network architecture, they may be candidates for TLS or E-LAN connectivity. E-LAN may be particularly cost effective if there are a number of branches in a different city from the main office, reducing the number (and cost) of inter-city links.

Positioning Mid-Band Ethernet Services amongst a range of options: In many aspects Mid-Band Ethernet services over copper are identical to Ethernet services over fiber. They both offer:

- Standard 10/100Base-T user-to-networkinterfaces;
- Symmetric capacity transparent to the Ethernet frames;
- Support for Ethernet 802.1Q/p Class of Service if required;
- Multiple VLANs with specific Ethernet and IP packet Quality of Service performance;

As such, both fiber and Mid-Band Ethernet services over copper are ideally suited to coexist as part of the same network.

But how would one service be positioned in relation to the other? Fiber-based Ethernet becomes economic to deploy in the access network when capacity requirements for a location begin to approach 100 MBps, or where one or more T3/STM-1 services (up to 45 Mbps) would be required. Service providers can obtain sufficient return on investment for the construction and deployment costs of fiber and related electronics to a location for this capacity requirement. Mid-Band Ethernet over copper can deliver access service capacity from 2 Mbps up to 100 Mbps over the copper already widely deployed in the access network by the local exchange carrier. Therefore, for the larger number of locations, Mid-Band Ethernet services fill the gap between T1/E1 and fiber-based services at a lower cost per bit to the enterprise customer.

SUMMARIZING THE VALUE PROPOSITION

The value proposition to prospective enterprise customers may be summarized along two lines, technical advantages and benefits, and business value:

THE TECHNICAL VALUE:

- Standards based – e.g. 10/100Base-T user-to-network interfaces and 802.1 protocols;
- Support for multiple Virtual LANs (VLANs) with different COS, enabling application specific QOS performance targets;
- Supports for point-to-point TLS, hub-and-spoke, and multi-point E-LAN architectures;
- Built-in resiliency – when using multiple, bonded copper pairs, losing one pair in the connection does not cut the entire service;
- Scalable – adding additional pairs to an existing Mid-Band Ethernet service allows an increase in capacity, automatically retraining to the higher speed without taking the circuit out of service;
- Wide availability – Available virtually everywhere, including the nearly 86% of business locations for which fiber has not been deployed.

THE BUSINESS VALUE:

- Ease of use and low cost of interface – uses widely available, inexpensive interface and switching/firewall equipment; no Frame Relay, ATM or T1/E1 interface cards are required;
- Widely available deployment and support knowledge, reduced or no training cost;
- Tailored – begin with the proper estimated level of required capacity for any application and add capacity as the number of applications and/or link utilization grows;
- Availability – begin to deploy high capacity enterprise applications, or mixed-use networks immediately, no waiting for service provider fiber construction delays;
- Reduced overall cost for service capacity in the 2-100 Mbps range.

Each prospective customer will have their own immediate concerns, applications they wish to deploy, and near term objectives for their network. The flexibility and cost effectiveness of Mid-Band Ethernet services over the existing copper infrastructure will enable rapid payback and high return on investment for any of their key enterprise initiatives.

CONCLUSION

Enterprise applications across all industry segments have already moved, or are rapidly moving, to exploit the ubiquity and cost effectiveness of IP and Ethernet. On-line transaction-oriented business applications with rapid response time have become critical to many businesses. Enterprise-wide PC and server networks are common in organizations both large and small. Ethernet-based Storage Area Network technologies allow organizations to implement Business Continuity/Disaster Recovery plans without incurring huge costs. VoIP Telephony has enabled the implementation of distributed call centers and global enterprise voice networks. Extensive use of videoconferencing, broadcast video, and on-line multi-media has facilitated improved business operations while reducing employee travel costs. Extending these internal applications to customers, employees, and business partners over the Internet through public web sites and Virtual Private

Networks is becoming common practice. These applications require networks with symmetric bandwidth, often tight performance objectives, and capacity in the range of 2 Mbps to 100 Mbps, particularly when grouped together in common networks.

Arguably all enterprise market segments: finance; health care; online and bricks-and-mortar retail; judicial and legal services; call center organizations; education; and Federal, State/Provincial, and municipal governments, Industrial and Manufacturing; have implemented these enterprise applications from head office to branch offices, within metro areas, across the country and in some cases around the world.

Ethernet protocols, physical interfaces and supporting technologies have been standardized, commercialized, and adopted to the degree that they provide the best bandwidth to cost ratio communications medium on the market today. Consequently organizations large and small are demanding metro and wide area Ethernet connectivity to interconnect their facilities, adopting site to site Transparent LAN interconnect services; multi-site E-LAN services; and dedicated Internet Access services in the 2-100 Mbps range (most frequently at 10 Mbps).

To serve these demands, Services Providers have stepped up their offerings of Carrier Ethernet services in the Metro, Inter-City, and global markets. Mid-Band Ethernet Services hit this sweet spot, filling the gap between T1/E1 and T3/STM-1 or fiber-based services. Unlike fiber-based access to business locations, Mid-Band Ethernet services are widely and readily available, efficiently making use of the copper plant already in place. Through standard pair-bonding techniques, high capacity, resilient, connectivity can be achieved cost effectively.

Selling Mid-Band Ethernet services to the enterprise customer demands an assessment of the prospect, their industry and the applications that they have implemented and wish to deploy. Assessing the customer's locations, the applications delivered to each site, and the bandwidth and performance requirements demanded by each, will identify those sites for which Mid-Band Ethernet services are ideally suited. These needs can be coupled with the Technical and Business Value propositions of Mid-Band Ethernet services previously outlined, unmatched by T1/E1 or fiber-based services, to demonstrate to the decision makers the significance of the opportunity available.

OVERTURE'S SOLUTION

OVERTURE'S FAMILY OF METRO ETHERNET SERVICE EDGE™ SOLUTIONS

Figure 3. Family of Metro Ethernet Service Edge™ Solutions

The Metro Ethernet Service Edge™ product family enables service providers to deliver high-speed, symmetrical business-grade Ethernet services to businesses over their existing last-mile copper infrastructure. Overture's Metro Ethernet Service Edge™ solutions allow service providers to fully leverage the benefits of offering data, voice over IP, and video services over Ethernet networks. With a low initial cost and plug-and-play installation, the product family easily scales from point-to-point applications to multipoint applications serving hundreds of customers from a single wiring center (Central Office, Remote Terminal, pole, or vault).

While other solutions offer transport and aggregation functions, the flexible architecture of the Overture solution provides the industry's first hardened, multi-service Ethernet system designed for the access network. Metro Ethernet Service Edge™ products allow multiple services per port using Overture's patented VLAN product architecture to provide both E-Line and E-LAN services as defined by the Metro Ethernet Forum (MEF), and an innovative Hub and Spoke service. With this feature, Overture's Mid-Band Ethernet solutions offer true Quality-of-Service, going beyond the simple Class-of-Service solutions of other vendors.

OVERTURE 4000i METRO ETHERNET SERVICE EDGE™ SWITCH

Overture's 4000i Metro Ethernet Service Edge™ switch is an innovative Ethernet in the First Mile (EFM) product that extends the reach of native Ethernet services to businesses that do not have access to fiber. The Overture 4000i delivers to each customer a 1-100 Mbps symmetric Ethernet service over 1 to 8 pairs of existing last-mile dry copper utilizing standards-based 2BASE-TL technology - effectively and efficiently bridging the existing T1/E1 – OC3/STM-1 service gap and economic disparity. With the Overture 4000i, high-margin Ethernet services can now be delivered over voice-grade copper at full carrier serving area (CSA) distances and beyond.

Packaged in a stackable high-density 1RU "pizza box", the Overture 4000i is purpose-built for deployment throughout the access network – in a central office (CO), controlled environmental vault (CEV), or remote terminal (RT). The fully front-accessible platform is standards-based, temperature-hardened, highly resilient and scalable. The Overture 4000i supports an industry-leading density of 40 pairs of 2BASE-TL per rack unit.

The Overture 4000i switch is fully compatible with the Overture 400-CPi series of cost-effective customer-premise demarcation devices. The connection between an Overture 4000i and an Overture 400-CPi device can consist of 1-to-8 copper pairs, bonded into a single 2BASE-TL broadband connection. IEEE 802.3ah 2BASE-TL copper pairs can be bonded from adjacent or non-adjacent binders, automatically bonding pairs into a logical connection when connected to an Overture 400-CPi.

The Overture 4000i implements the IEEE standard for Ethernet OAM with extensions for complete remote management and control to simplify deployment and management, while maintaining full interoperability with existing Ethernet switches, routers and Ethernet ADM interfaces.

In cases where maximum port density is required, Overture's patented Virtual Node (VN) technology enables service providers to deploy multiple load-sharing systems as a single managed entity. Unlike other vendor offerings, the Overture VN is managed as a single node, providing a fully-redundant architecture and industry leading port density.

OVERTURE 4000 VIRTUAL NODE (VN) METRO ETHERNET SERVICE EDGE™ SWITCH

Overture's 4000 Virtual Node consists of up to five Overture 4000is (capable of supporting 200 2BASE-TL pairs), redundantly connected using a dedicated ring-based stacking interface to create a Virtual Node that enables carriers to incrementally add service capacity. Overture 4000i platforms can be hot-inserted into an operational stack, with no impact to existing services. The Overture 4000VN implements a distributed cross-box bonding mechanism that frees the carrier from the inventory and planning issues typically associated with multi-pair systems – any pair can be aggregated with any other pair, anywhere across multiple Overture 4000is in the VN.

A fully-stacked Overture 4000VN supports all of the functionality of an Overture 4000i and is fully compatible with the Overture 400-CPi series of cost-effective customer-demarcation devices.

OVERTURE 4000I AND OVERTURE 4000VN HIGHLIGHTS

- Completely standards-based and spectrally compatible solutions
- Complete Quality-of-Service rather than simple class-of-service solutions
- Complete business-grade resiliency rather than a semi-redundant system

- Complete carrier-grade OAM on an Ethernet network - managed via industry-standard CLI, TL1, WebManager, EMS, SNMP, and IBM Tivoli Netcool/OMNIbus integration
- Ultra-compact, front access products with industry leading port density per rack unit
- Full temperature hardening for versatile deployment
- NEBS3, ETSI and OSMINE certified
- Plug-and-play turn up of services reduces OPEX and time to revenue
- Patented VLAN-aware product architecture enabling multiple services per physical connection, with a smooth migration from tag stacking to MPLS
- Sharing of single or multiple network uplinks across hundreds of customers
- Distributed bonding of copper pairs across multiple units for ultimate business class resiliency, simplified pair management, and no stranded ports
- Robust architecture preventing any single points of system failure using redundant, Virtual Node interconnections with distributed management control agents

OVERTURE 4000I AND OVERTURE 4000VN APPLICATIONS

- High-speed symmetrical Ethernet transport/access
- Extension of existing fiber-based Ethernet services
  - Ethernet Private Line
  - Ethernet Virtual Private Line
  - Ethernet Private LAN
  - Ethernet Virtual Private LAN
  - Hub & Spoke
- Wireless tower and DSLAM backhaul
- MDU/MTU, campus networks, universities, government, etc.
- Converged access and transport where per-service SLAs are required for voice, video and data – all over a single physical connection

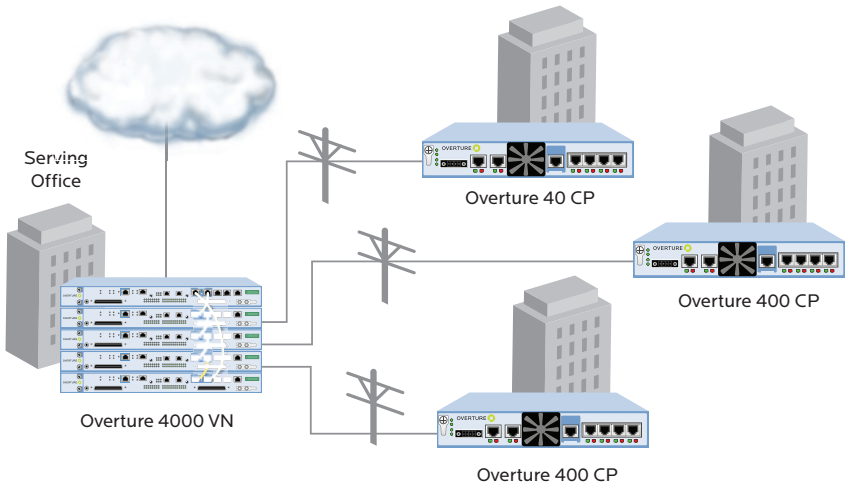

Figure 4. 4000i Multipoint Application

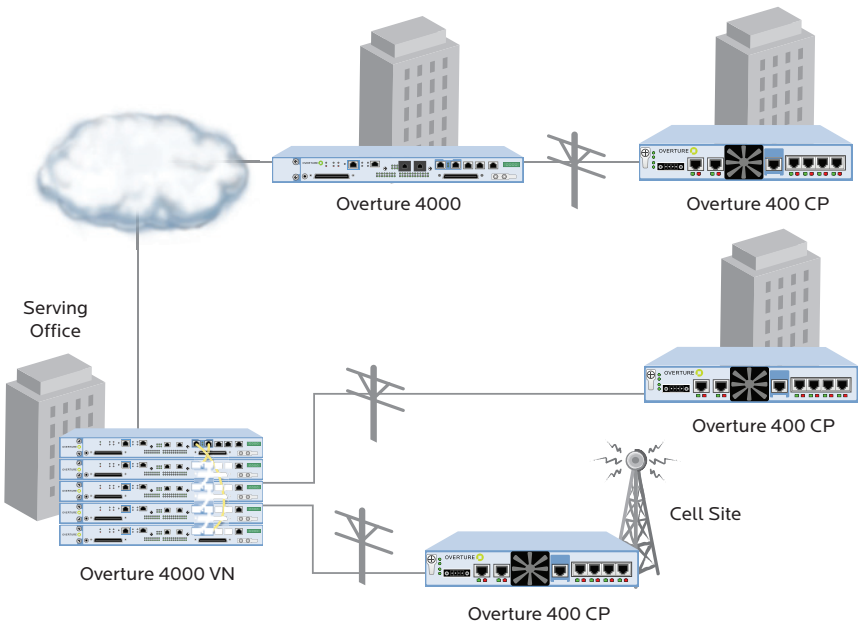

Figure 5. 4000VN Multipoint Applications - CO and Remote Terminal

OVERTURE 400-UI METRO ETHERNET SERVICE EDGE™ SWITCH

The Overture 400-Ui (Universal for CO or CP deployment) is an innovative product that extends the reach of native Ethernet services to businesses without access to fiber. The Overture 400-Ui delivers point-to-point symmetrical Ethernet bandwidth and services at rates up to 100 Mbps over existing copper pairs utilizing standards-based 2BASE-TL technology. The Overture 400-Ui provides a low-cost market-entry solution for extending Ethernet to the customer premise.

The Overture 400-Ui is a carrier-class, temperature-hardened platform that enables carriers and service providers of all sizes to deliver service-rich business broadband services on basic last-mile copper pairs. By extending native Ethernet to business customers without fiber access, the Overture 400-Ui offers greater service flexibility and efficiency than existing private-line or asymmetrical services do today. Using the Overture 400-Ui, carriers are able to leverage existing copper assets to deliver new services with the quality of traditional private-line services.

The Overture 400-Ui platform is fully compatible with the Overture 400-CPi series of cost-effective customer-demarcation devices. The connection between an Overture 400-Ui and an Overture 400-CPi device can consist of 1-to-8 copper pairs, bonded into a single 2BASE-TL broadband connection.

The Overture 400-Ui implements the IEEE 802.3ah standard for Ethernet OAM with extensions for complete remote management and control to simplify deployment and management. The Overture 400-Ui uses essentially the same CLI as the Overture 4000i.

The Overture 400-Ui reduces the risk and enhances the reward associated with offering new services by leveraging the existing copper infrastructure and seamlessly integrating into the carrier's operational processes.

OVERTURE 400-UI HIGHLIGHTS

- High-speed symmetrical bandwidth and Ethernet services over copper
- Cost-effective point-to-point solution - profitable with a single customer
- Standards-based utilizing 802.3ah - 2BASE-TL
- Full temperature hardening for versatiledeployment
- NEBS3, ETSI and OSMINE certified
- Complete carrier-grade OAM on an Ethernet network - managed via industry-standard CLI, TL1, WebManager, EMS, SNMP, and IBM Tivoli Netcool/OMNIbus integration

- Plug-and-play turn up of services reduces OPEX and time to revenue
- Easy migration to Overture 4000is as more customers are added to the network

OVERTURE 400-UI APPLICATIONS

- High-speed symmetrical Ethernet transport/access
- Ethernet Private Line Service
- Ethernet Virtual Private Line Service
- Wireless tower and DSLAM backhaul
- MDU/MTU, campus networks, universities, government, etc.

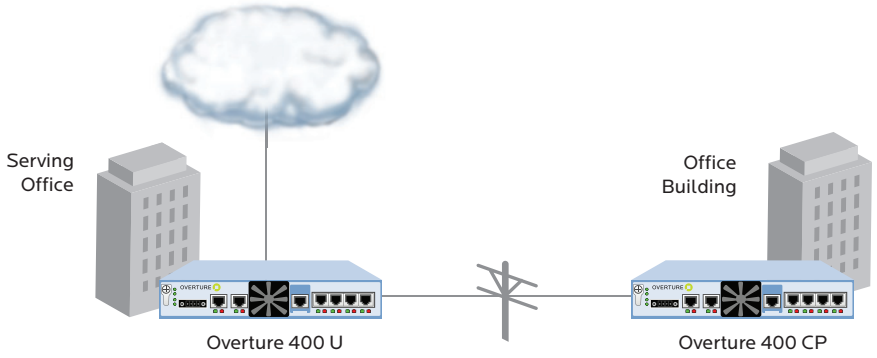

Figure 8. Overture 400i Point-to-Point Application

ABOUT OVERTURE

Overture is headquartered in Research Triangle Park, North Carolina and was started several years ago to develop high-performance telecommunications access platforms. Overture was formed to enable telecommunications service providers to deliver cost-effective, service-rich, high-speed access in the last mile to business customers - one of the most difficult challenges carriers face today. Removing this critical bottleneck in the access network is necessary to fuel future growth in broadband, multimedia and Internet services. To date, capital-intensive fiber-based solutions have been the most widely deployed means for meeting this challenge.

Overture provides standards-based Ethernet access solutions, which leverage the fully ratified Ethernet in the First Mile (EFM) standards from the IEEE and ITU. With Overture's solutions, carriers can migrate from the complexity and expense of TDM-based T1/E1 circuits, to the simplicity and availability of a pure Ethernet access platform, all while increasing the bandwidth to, and revenue potential of each customer.

Overture is a founding member of the Ethernet in the First Mile Alliance, and was a leader in the development of the IEEE 802.3ah standards for delivering symmetrical Ethernet services natively over copper access loops. Overture's corporate commitment to standards and interoperability provides our customers with the certainty that their capital investments are protected.

Carriers from around the world have deployed Overture's Mid-Band Ethernet solutions, enabling them to drive down access costs by eliminating the cost and complexity of ATM and T1/E1 solutions, and increase revenue with higher bandwidth, value-added services.

Visit **www.overturenetworks.com** for additional information.

EXTENDING THE ETHERNET SERVICES EDGE

Overture enables an emerging market segment referred to as Mid-Band Ethernet. The Mid-Band Ethernet service enables Carriers to deliver the Metro Ethernet services over the existing copper infrastructure to businesses whose application requirements fall within the bandwidth gap between T1/E1 and T3/STM-1. While the Overture solutions deliver up to 100 Mbps over 8 copper pairs, the Mid-Band Ethernet service sweet spot is 2-45 Mbps (the gap between T1/E1 and where fiber deployment becomes economically viable).

Mid-Band Ethernet services are exactly the same as those enabled by Metro Ethernet:

- Transparent LAN Services (TLS)
- Direct Internet Access (DIA)
- Voice over IP (VoIP)
- Ethernet Private Line
- Storage Area Networks (SANs)
- etc...

Therefore, an essential requirement of Mid-Band Ethernet equipment is the ability to transparently extend existing Metro Ethernet services beyond fiber.

Vertical System Group estimates that in the U.S. and Europe over 2.2 million T1/E1, Frame Relay and T3/STM-1 connections will migrate to Mid-Band Ethernet links over the next 5 years. Overture Ethernet Service Edge solutions enable this new market segment that is expected to generate over $15B per year in service revenue for U.S. and European Carriers. The opportunity in Europe and other international markets is the same order of magnitude.

ABOUT OVERTURE

Overture is the preferred Carrier Ethernet edge and aggregation partner to more than 450 service providers and enterprise customers worldwide. By providing the entrance to a better network, service providers can leverage Carrier Ethernet to multiply revenue and streamline operational costs by enabling high-capacity Ethernet services over any physical media, including fiber, copper and TDM. Overture's solutions are designed for reliability and ease of use, and arm customers to compete for demanding applications such as cloud computing and mobile communications that require greater bandwidth and smarter networks. Overture is headquartered in Research Triangle Park, NC, with a technology center in Richardson, Texas. For more information, visit **www.overturenetworks.com.**

OVERTURE

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